3. Extension Folder 264
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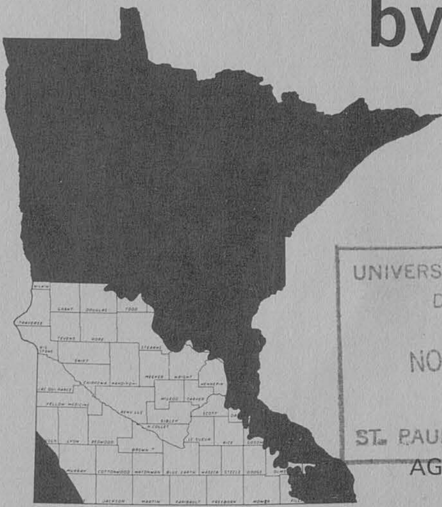
Soil Management by Fall Tillage for Corn



J.B. Swan
W.W. Nelson
R.R. Allmaras

AGRICULTURAL EXTENSION SERVICE 2.
UNIVERSITY OF MINNESOTA 1.

Fall plowing is a key management tool for Minnesota farmers in the Clarion-Nicollet-Webster soil association area and similar soils in southern and western Minnesota. On these moderately well-drained to poorly drained soils with clay loam or finer texture, fall plowing frequently provides a superior seedbed and reduces spring seedbed preparation time. Research conducted jointly by the University of Minnesota Southwest Experiment Station at Lamberton* and the Agricultural Research Service, USDA at Morris* showed that fall plowing increased yields about 10 percent. Fall plowing modifies the overwinter heat balance and increases spring soil temperatures, which greatly increase early corn growth on these soils. At planting time, the plow layer in fall plowing is drier and is composed of smaller aggregates. This provides greater seed-soil contact and more rapid water and nutrient movement to the seed and plant roots.

Shortening the time required for spring tillage is important because early planting of corn increases yields. Research shows that corn yields decrease in southern Minnesota as planting is delayed after the first week in May. At the Lamberton Experiment Station, May soil conditions are suitable for an average of only 15½ days' field work.

Yields

Increases in corn yields from fall plowing are frequently observed on less well-drained, finer-textured soils in the northern corn belt. Ohio results show that fall plowing raised corn yields about 10 bushels an acre on some dark-colored, poorly drained soils.

In 6 years at the Lamberton Experiment Station, corn yields on a Nicollet clay loam averaged 83 bushels per acre for fall plowing versus 73 bushels per acre for spring plowing (table 1). Both were planted on the same date. Since fall plowing can frequently be planted earlier than spring plowing, true yield differences may actually be greater than measured. This is likely because as corn growth and development is advanced, an August drought will less affect yield. This happened in 1966.

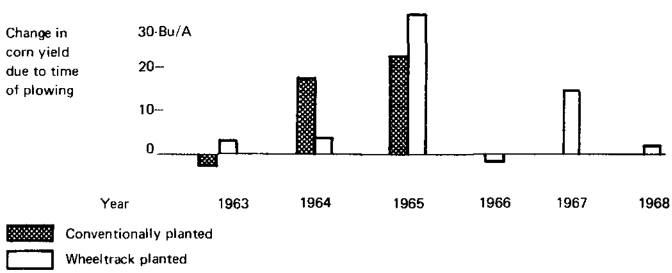
In 3 years (1963, 1966, and 1968) yield differences were less than 3 bushels per acre; in 3 years (1964, 1965, and 1967) yield differences ranged between 10 and 30 bushels per acre in favor of fall plowing (figure 1). Apparently the early growth on fall plowing had greater yield potential, which occurred in 1964, 1965, and 1967. However, environmental factors such as drought overwhelmed any potential difference in yield in 1963, 1966, and 1968. In all years except 1965, corn followed corn. In 1965, corn followed a 1964 small grain crop.

Table 1. Comparison of corn yields on fall plowing and spring plowing at Lamberton—1963-1968

Year		1963	1964	1965	1966	1967	1968	Average 1963-68
Time of plowing	Planting method							
Fall	Conv.*	93	70	66	–	–	–	83
	WT†	87	55	69	78	99	130	
Spring	Conv.	95	53	42	–	–	–	73
	WT	86	52	35	79	82	130	

* = conventionally planted
† = wheeltrack planted

Figure 1. Yield increase from fall plowing



However, on well-drained, medium-textured soils, Minnesota and Iowa research results generally showed either no yield differences or small yield differences between fall and spring plowing. In Iowa research on well-drained Clarion soils, fall plowing outyielded spring plowing by 5 percent where corn followed oats in a corn-oats rotation. In 5 years of research at Sutherland, Iowa, on a well-drained, medium-textured soil in northwestern Iowa, no appreciable yield differences occurred between fall- and spring-plowed soybean ground: 92 and 91 bushels per acre average yields, respectively. A possible reason why greater yields were not obtained on fall plowing at Sutherland may be failure to obtain a rough surface on fall-plowed soybean ground.

Research Results from Southwest Experiment Station, Lamberton

Seedbed

Fall plowing on Nicollet clay loam at Lamberton provided a more suitable seedbed for corn than spring plowing. The same would be true for other southern Minnesota soils which are moderately well to somewhat poorly, poorly, and very poorly drained such as Aastad, Svea, Flom, Skyberg, Kenyon, Clyde, LeSueur, Cordova, Glencoe, Marna, and Medilia soils. The map shows the counties where these soils are located.

The spring soil temperature was 1 to 2° F. greater and the plow layer was drier at planting time on fall plowing, therefore, planting can be earlier on fall plowing. Earlier planting is a distinct advantage since only half of May is available for tillage, and research shows yield benefits from early planting.

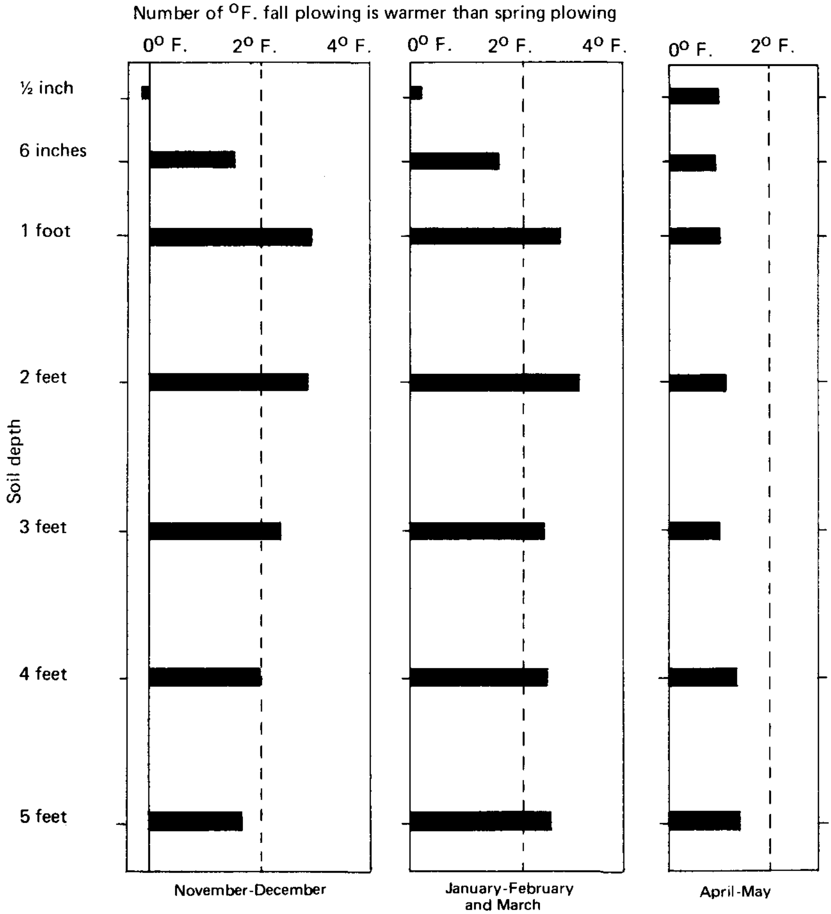
Average aggregate size was smaller with fewer large clods on fall plowing. This provided greater seed-soil contact and more rapid movement of nutrients and water to the seed and young plant. Spring plowing does not have the granulating action of overwinter weathering to break down the large clods. Few roots developed where the aggregate size in the plow layer was large. Since the phosphorus available to the plant occurs mainly in the plow layer, a large aggregate size lessened phosphorus uptake. This condition was more frequent with spring plowing.

Overwinter Heat Balance Affects Soil Temperature

Differences in soil temperature between fall and spring plowing were measured to a depth of 5 feet (figure 2). These differences occurred as early as December and persisted into June of some years. Time of plowing strongly affected the overwinter heat balance. Spring plowing treatments lost greater amounts of heat than fall plowing. When no snow cover was present, the net radiant energy absorbed by the fall plowing and converted to heat was greater than on the spring plowing.

The rougher bare surface of the fall plowing was an important factor in causing different net radiant energy received by fall and spring plowing. At low sun angles, net radiation was greater on the rougher-surfaced, fall-plowed area than on the untilled area to be spring-plowed, where the stalk cover had been removed. No snow cover was present when these measurements were made. Surface residue on the area to be spring plowed caused an additional decrease of net radiant energy at the soil surface.

Figure 2. Daily average soil temperature difference for 1967-1968 in °F. due to fall and spring plowing—Lamberton (temperature of fall minus spring plowing)



Lamberton research indicates that the form of fall tillage (i.e., fall plowing or chiseling) may not matter so long as the tillage provides a bare, randomly rough surface. The greater the random roughness of the surface, the greater the benefits at low sun angles.

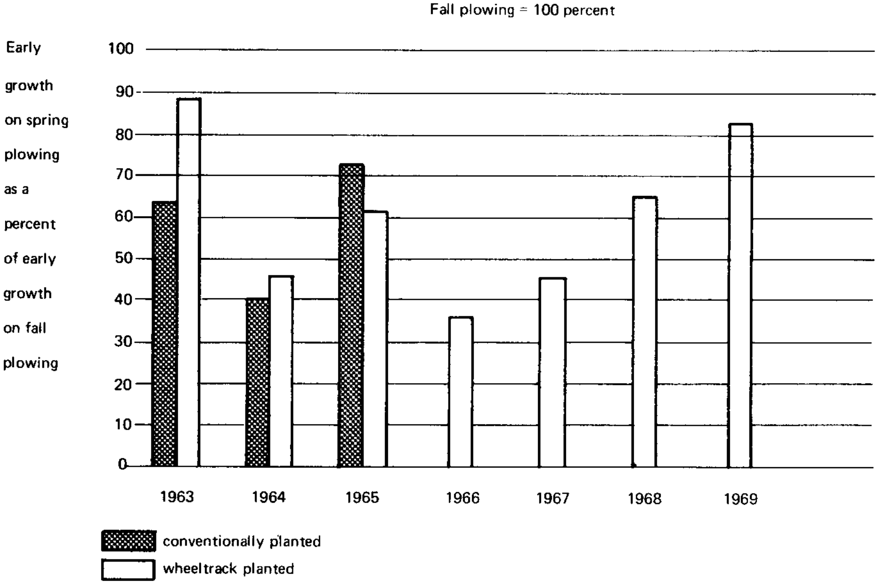
Mulches of plant residue, if sufficiently heavy, will cancel out the beneficial effect of a rough surface on the overwinter thermal heat balance. Corn stalk residues of 2 to 3 tons per acre appear sufficient to neutralize the 1 to 2^{o} F. increase in soil temperature caused by fall plowing. Soybean residue commonly ranges between 1,500 and 2,500 pounds per acre. If 50 percent is buried by a tillage operation, only about 1,000 pounds of residue would be left on the surface. The temperature reduction by 1,000 pounds of soybean residue should be small and there should still be a beneficial effect of the rough surface on the overwinter heat balance.

Soil Temperatures and Early Growth

Average daily spring soil temperatures are generally well below optimum for corn on most medium- and finer-textured soils in southern Minnesota and are lowest and most critical on the less well-drained soils. Therefore, on the less well-drained soils, corn growth during the first 30 to 60 days is strongly affected by soil temperature. Average daily 4-inch soil temperatures at Lamberton on a Nicollet clay loam in May are in the 60's and early corn growth is increased markedly when soil temperatures increase 1 to 2^{o} F.

May soil temperatures were consistently higher on fall plowing. This caused increased early growth on fall plowing. Early corn growth on spring plowing averaged about 60 percent of that on fall plowing at Lamberton. With wheeltrack and plow-disk-harrow planting, spring plowing ranged from 37 to 88 percent as much early growth as fall plowing, at 41 to 50 days after planting (figure 3).

Figure 3. Comparisons of early growth of corn at 41 to 50 days after planting on fall and spring plowing at Lamberton—1963-1969

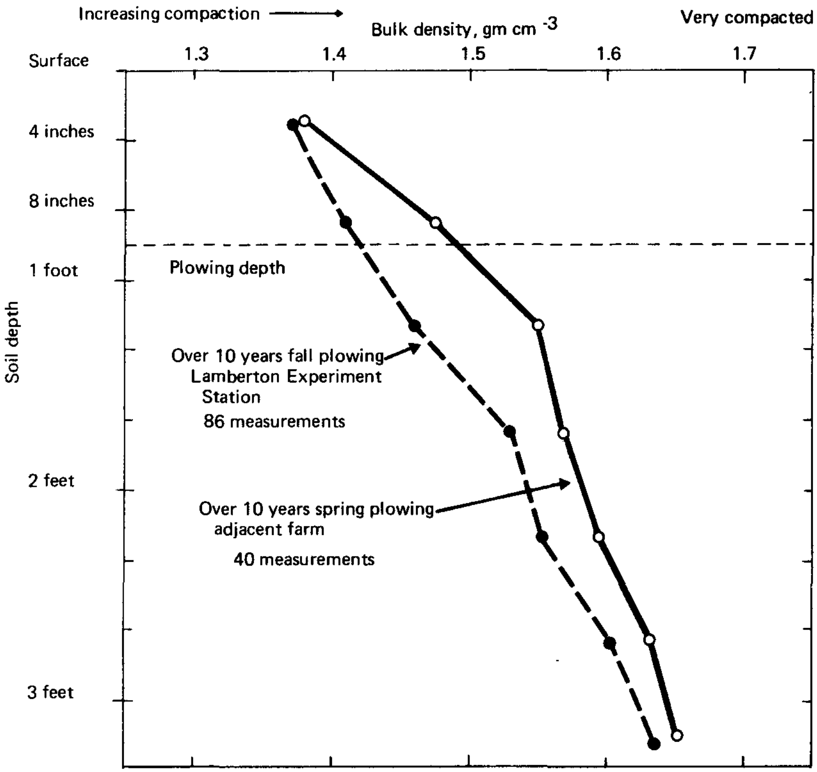


Compaction

Soil moisture conditions are commonly more favorable for fall plowing. This, together with overwinter weathering, reduced clod problems caused by soil compaction in the plow layer. There is generally less compaction below the plow layer due to tractor weight and wheel slip in the furrow with fall plowing because this layer is usually much drier in the fall. After 10 years of fall plowing at Lamberton, compaction, as measured by bulk density, was less than on an adjoining farm with the same soil type that was spring plowed (figure 4).

Research shows that a compacted layer can slow the rate that water enters the soil. After a rain, the plow layer remains wetter where the subsoil was compacted. Thus, compaction may delay spring tillage, increase evaporation, and decrease the net water stored.

Figure 4. Differences in soil compaction under fall and spring plowing



Increased Erosion Hazard

Where wind and water erosion is a hazard, the temperature advantages of incorporating surface residue below the soil surface must be balanced against potential increased erosion. A rough surface is initially effective in decreasing runoff. After sealing of the surface due to overwinter freezing and thawing, the roughness is no longer effective in decreasing runoff. On such a surface, spring secondary tillage, such as disking, is of little benefit in increasing infiltration. However, the same result occurs with any bare surface following overwinter weathering except where sizable ridges and furrows are left on the contour. To solve these problems, conservation measures such as chisel plowing and terracing should be considered. Chisel plowing should be done in the fall when the soil is dry and more apt to benefit from the shattering action of the chisel. By mid-to-late October, on many moderately fine textured soils in southern Minnesota, the top foot of soil is frequently near field capacity. Shattering action is drastically reduced at this water content. Soils in spring in Minnesota are frequently too wet to shatter satisfactorily.

*Allmaras, R. R., W. W. Nelson, and E. A. Hallauer. Fall versus spring plowing and related soil heat balance in the Western Corn Belt. University of Minnesota Technical Bulletin No. 283. University of Minnesota Agricultural Experiment Station. 1971. This Extension Folder 264 is based on Technical Bulletin 283.

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J.B. Swan is associate professor and extension specialist, Soils, University of Minnesota; W.W. Nelson is professor, Soils, and superintendent, Southwest Experiment Station, Lamberton, Minnesota Agricultural Experiment Station; and R.R. Allmaras is soil scientist, USDA, Columbia Plateau Conservation Research Center, Pendleton, Oregon. He was formerly at the North Central Soil Conservation Research Center, Morris, Minnesota.

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